CLAIMS

What is claimed is:

1. A method for fabricating a thermal management system for a micro-component device, comprising:

overlaying a target substrate with a blank in sheet form;

stamping a microchannel structure having a plurality of outer walls enclosing a predefined area from the blank;

bonding the microchannel structure to a heat dissipating side opposite from a micro-component device facing side of a first substrate, the micro-component device facing side adapted to thermally engage with the micro-component device;

bonding the microchannel structure to a second substrate opposite the first substrate, defining a closed volume microchannel; and

substantially filling the microchannel with a fluid thermal interface material.

2. The method of claim 1, wherein stamping a microchannel structure having a plurality of outer walls enclosing a predefined area from the blank, comprises:

providing a press tool having a predetermined relief structure with cutting blades adapted to cut the blank;

pressing the press tool into the blank such that the cutting blades cut through to the target substrate, cutting the blank into a microchannel structure and waste portions, the microchannel structure comprising a plurality of outer walls defining an edge seal enclosing a predetermined area of the target substrate; and

removing the waste portions.

3. The method of claim 2, wherein providing a press tool having a predetermined relief structure with cutting blades adapted to cut the blank comprises:

providing a press tool having a predetermined relief structure with cutting blades adapted to cut the blank, the relief structure having an inner surface between adjacent cutting blades; and

wherein pressing the press tool into the blank such that the cutting blades cut through to the target substrate, cutting the blank into a microchannel structure and waste portions, comprises:

pressing the press tool into the blank such that the cutting blades cut through to the target substrate cutting the blank into a microchannel structure and waste portions, the inner surface applying a predetermined compressive force onto the microchannel structure to facilitate a fluid-tight diffusion bond between the microchannel structure and the target substrate.

4. The method of claim 1, wherein bonding the microchannel structure to a first substrate comprises:

bonding the microchannel structure to the target substrate, wherein the target and first substrates are one and the same.

5. The method of claim 4, wherein bonding the microchannel structure to a first substrate comprises:

applying a compressive force between the first substrate and the microchannel structure to effect a fluid-tight diffusion bond between the first substrate and the microchannel structure.

6. The method of claim 5, wherein applying a compressive force between the target substrate and the microchannel structure to effect a fluid-tight diffusion bond between the target substrate and the microchannel structure comprises:

applying a compressive force at an elevated temperature below the melt temperature of either the target substrate and the microchannel structure over a predetermined period of time to effect a fluid-tight diffusion bond between the target substrate and the microchannel structure.

7. The method of claim 1, wherein bonding the microchannel structure to a second substrate opposite the first substrate, defining a closed volume microchannel comprises:

providing a second substrate onto the microchannel structure opposite the target substrate; and

applying a predetermined compressive force to the second substrate and microchannel structure sufficient to provide a fluid-tight diffusion bond there between.

8. The method of claim 7, wherein applying a predetermined compressive force to the second substrate and microchannel structure sufficient to provide a fluid-tight bond there between comprises:

applying a predetermined compressive force at an elevated temperature below the melt temperature of either the target substrate, second substrate, and the microchannel structure, over a predetermined period of time to effect a fluid-tight diffusion bond between the second substrate and the microchannel structure.

9. The method of claim 1, wherein substantially filling the microchannel with a fluid thermal interface material comprises:

substantially filling the microchannel with an indium alloy that is liquid at a predetermined micro-component device operating temperature.

10. The method of claim 1, further comprising thermally coupling the micro-component device facing side of the first substrate with a heat-producing side of the micro-component device.

11. The method of claim 10, wherein thermally coupling the micro-component device facing side of the first substrate with a heat-producing side of the micro-component device comprises:

thermally coupling the micro-component device facing side of the first substrate with a backside of a microelectronic die, the microelectronic die comprising integrated circuits.

12. The method of claim 11, further comprising:

thermally coupling the fluid thermal interconnect material with one or more thermal dissipation devices selected from the group consisting of heat pipe, thermal dissipation fins, fan, heat exchanger, and flat plate.

13. A micro-component device package, comprising:

a micro-component device comprising a die and a carrier substrate, the die having a backside, the die being electrically interconnected with the carrier substrate; and

a thermal management system in thermal engagement with the backside, the thermal management system comprising:

a first substrate having a die facing side and an opposite heat dissipation side, the die facing side thermally coupled to the back side of the die;

a microchannel structure having a plurality of outer walls enclosing a predefined area, the microchannel structure coupled to the heat dissipation side of the first substrate;

a second substrate, the second substrate coupled to the microchannel structure, the first substrate, microchannel structure and the second substrate defining a closed volume microchannel; and

a thermal interface material disposed within the closed volume microchannel.

14. The micro-component device package of claim 13, wherein the first substrate includes an integrated heat spreader and the second substrate includes a heat sink.

15. The micro-component device package of claim 13, wherein the thermal management system further comprises:

an inlet aperture through the outer wall in fluid communication with the microchannel; and

a vent aperture through the second substrate or the outer wall, the vent aperture in fluid communication with the microchannel.

16. The micro-component device package of claim 15, wherein the vent aperture includes a semi permeable membrane plug adapted to allow the passage of gas but not the fluid thermal interface material.

17. The micro-component device package of claim 15, wherein the thermal management system further comprises:

a thermal interface material supply line coupled to the inlet aperture;

a thermal interface material discharge line coupled to the vent aperture; and

a micropump coupled to the supply line and the discharge line, the micropump configured to provide a pressure differential to circulate the fluid thermal interface material from the supply line, through the microchannel, and to the discharge line.

18. The micro-component device package of claim 17, wherein the thermal management system further comprises a heat exchanger in fluid communication with the microchannel, the heat exchanger adapted to dissipate thermal energy from the fluid thermal interface material.

19. The micro-component device package of claim 13, wherein the thermal interface material is selected from a group including indium alloy, Ga-In-Sn Alloy, Cesium Francium, and Rubidium.

20. The micro-component device package of claim 13, wherein the micro component device is an integrated circuit.

21. A system comprising:

a selected one of a digital signal processor and a graphics processor; and

a micro-component device package coupled to the selected one of a digital signal processor and a graphics processor, including

a micro-component device comprising a die and a carrier substrate, the die having a backside, the die being electrically interconnected with the carrier substrate; and

a thermal management system in thermal engagement with the backside, the thermal management system comprising:

a first substrate having a die facing side and an opposite heat dissipation side, the die facing side thermally coupled to the back side of the die;

a microchannel structure having a plurality of outer walls enclosing a predefined area, the microchannel structure coupled to the heat dissipation side of the first substrate;

a second substrate, the second substrate coupled to the microchannel structure, the first substrate, microchannel structure and the second substrate defining a closed volume microchannel; and

a thermal interface material disposed within the closed volume microchannel.

22. The system of claim 21, wherein the first substrate of the thermal management system of the micro-component device package includes an integrated heat spreader and the second substrate includes a heat sink.

23. The system of claim 21, wherein the thermal management system further comprises:

an inlet aperture through the outer wall in fluid communication with the microchannel; and

a vent aperture through the second substrate or the outer wall, the vent aperture in fluid communication with the microchannel.

24. The system of claim 23, wherein the vent aperture includes a semi permeable membrane plug adapted to allow the passage of gas but not the fluid thermal interface material.

25. The system of claim 23, wherein the thermal management system further comprises:

a thermal interface material supply line coupled to the inlet aperture;

a thermal interface material discharge line coupled to the vent aperture; and

a micropump coupled to the supply line and the discharge line, the micropump configured to provide a pressure differential to circulate the fluid thermal interface material from the supply line, through the microchannel, and to the discharge line.

26. The system of claim 25, wherein the thermal management system further comprises a heat exchanger in fluid communication with the microchannel, the heat exchanger adapted to dissipate thermal energy from the fluid thermal interface material.

27. The system of claim 21, wherein the thermal interface material is selected from a group including indium alloy, Ga-In-Sn Alloy, Cesium Francium, and Rubidium.